


JP 4-101286

CERTIFICATE OF TRANSLATION

I, SHUSAKU YAMAMOTO, patent attorney of Fifteenth Floor, Crystal Tower, 1-2-27 Shiomi, Chuo-ku, Osaka 540-6015, Japan HEREBY CERTIFY that I am acquainted with the English and Japanese languages and that the attached English translation is a true English translation of what it purports to be, a translation of Japanese Laid-open Utility Model Publication No. 4-101286, entitled "High-Efficiency Power Supply Circuit", laid-opened on September 1, 1992.

Additionally, I verify under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed this 11th day of June, 1998.


SHUSAKU YAMAMOTO



SHUSAKU YAMAMOTO

Your Ref: 02445.037

Translation of Japanese Laid-Open Utility Model Publication

Laid-Open Utility Model Publication Number: 4-101286

Laid-Open Publication Date: September 1, 1992

Title of the Invention: HIGH-EFFICIENCY POWER SUPPLY
CIRCUIT

Utility Model Application Number: 3-994

Filing Date: January 17, 1991

Inventor: S. MORIOKA

Applicant: TOSHIBA CORPORATION and TOSHIBA COMPUTER
ENGINEERING, CO. LTD.

[Title of the Invention] High-efficiency power supply
circuit

[Claim]

[Claim 1] A high-efficiency power supply circuit implemented as a DC-DC converter comprising: a first switching element to be turned ON/OFF in response to an external signal; an inductor for supplying energy to a load in accordance with a state of the first switching element; a rectifying diode; and a smoothing capacitor, wherein the high-efficiency power supply circuit is characterized by further including a second switching element which is connected in parallel to the rectifying diode, and is controlled to be bidirectionally turned ON/OFF in synchronism with the first switching element, and a comparator for detecting a voltage drop by the rectifying diode and the second switching element and detecting the direction of current flowing through the inductor, thereby turning

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ON/OFF the second switching element.

[Detailed Description of the Invention]

[0001]

[Objective of the Invention]

[0002]

[Field of the Invention]

This invention relates to a high-efficiency power supply circuit such as a DC-DC converter suitably applicable to portable units like personal computers, in particular.

[0003]

[Prior Art]

In a portable unit such as a personal computer, a DC-DC converter is used as a power supply. A basic configuration of a DC-DC converter is shown in Figure 2. The DC-DC converter includes: a switching element 21, such as a bipolar transistor or an MOS transistor, which is turned ON/OFF in response to an external signal; an inductor element 22 such as a coil for storing energy therein or a choke for changing the magnitude of a voltage; a smoothing capacitor 23; and a rectifying diode 24.

[0004]

The basic operation thereof is as follows. First, when the switching element 21 is turned ON, current I_{on} flows, so that energy is supplied from the side of

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an input terminal to the side of an output terminal. On the other hand, when the switching element 21 is turned OFF, current I_{off} flows, so that the energy stored in the inductor 22 is released. At this time, a part of the energy stored in the inductor 22 is lost because of a forward voltage drop of the rectifying diode 24.

[0005]

Another configuration of a DC-DC converter which has been modified for reducing the loss caused by the diode is shown in Figure 3. Specifically, another switching element 31, the switching of which is controlled such that the switching element 31 is bidirectionally turned ON/OFF in synchronism with the switching element 21, is provided separately from the switching element 21 for the configuration shown in Figure 2. A timing relationship between these switching elements is defined such that when the switching element 21 is ON, the switching element 31 is turned OFF, and that when the switching element 21 is OFF, the switching element 31 is turned ON. This configuration utilizes a fact that a voltage drop between the source and the drain of the bidirectional switching element 31 is considerably smaller than a forward voltage drop of the diode 24.

[0006]

[Problems to be Solved by the Invention]

In the configuration shown in Figure 3, in an operation mode in which the switching element 21 is turned ON after all of the energy stored in the inductor 22 has

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completely been released (i.e., extra energy which is not consumed by the load returns to the power supply), the extra energy which is not consumed by the load is once stored as magnetic energy in the inductor 22, and then returns as electric energy to the power supply. Since the energy returns from a light load to the power supply in such a manner, a power loss is caused and the efficiency of the power supply is decreased at this time. Thus, power cannot be supplied to a largely variable load, irrespective of the state of the load. Moreover, if such a situation is to be avoided by the circuit configuration shown in Figure 3, then the capacitance of the inductor 22 adversely increases.

[0007]

This invention has been devised in view of the above-described state in the art, for the purpose of providing a high-efficiency power supply circuit which can efficiently supply power even when a load is light.

[0008]

[Structure of the Invention]

[0009]

[Means for Solving the Problems]

This invention is a DC-DC converter including: a first switching element to be turned ON/OFF in response to an external signal; an inductor for supplying energy to a load in accordance with a state of the first switching element; a rectifying diode; and a smoothing capacitor.

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The high-efficiency power supply circuit is characterized by further including a second switching element which is connected in parallel to the rectifying diode, and is controlled to be bidirectionally turned ON/OFF in synchronism with the first switching element, and a comparator for detecting a voltage drop by the rectifying diode and the second switching element and detecting the direction of current flowing through the inductor, thereby turning ON/OFF the second switching element.

[0010]

[Function]

In the above-described configuration, the direction of the current flowing through the inductor is detected by the comparator, and the turn ON/OFF of the second switching element is controlled in accordance with the output of the comparator, thereby realizing a power supply exhibiting a high efficiency even when the load is light. Thus, even when the load is light, the efficiency does not decrease and the capacitance of the inductor need not be increased.

[0011]

[Examples]

Hereinafter, an example of the present invention will be described in detail with reference to the drawings. Figure 1 is a circuit diagram showing an example of the present invention.

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[0012]

In Figure 1, 11 is a switching element, such as a bipolar transistor or an MOS transistor, which is turned ON/OFF in response to an external signal, 12 is an inductor element such as a coil for storing energy therein or a choke for changing the magnitude of a voltage, and 13 is a smoothing capacitor. 14 is a switching element which is provided separately from the switching element 11 and the switching of which is controlled such that the switching element 14 is bidirectionally turned ON/OFF in synchronism with the switching element 11. 15 is a comparator for detecting the voltage drop of the switching element 14 and detecting the direction of current flowing through the inductor 12, thereby turning ON/OFF the switching element 14 in accordance with the direction. 16 and 17 are parasitic diodes.

[0013]

Hereinafter, the operation of this exemplary power supply circuit according to the present invention will be described in detail. As shown in Figure 1, first, when the switching element 11 is turned ON, if the switching element 14 is also ON (a specific operation mode in which the switching element 14 is ON will be described later), then current I_{om} flows through the switching element 11 → the switching element 14 → GND in this order. A signal to be activated in accordance with the output of the comparator 15 (a high-level signal) is supplied to the switching element 14. However, when the current I_{om} flows through the switching element 14, a certain voltage drop is

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caused between the terminals of the switching element 14. As a result, the point denoted by a in Figure 1 has a positive (+) polarity and the point denoted by b in Figure 1 has a negative (-) polarity. Then, the output of the comparator 15 becomes low and the switching element 14 is turned OFF. After the current stops flowing through the switching element 14, the output of the comparator 15 is still low. When the switching element 14 is turned OFF, current I_{on2} begins to flow from the power supply to the load.

[0014]

Next, when the switching element 11 is turned OFF, the energy stored in the inductor 12 is released and current I_{off1} flows. At this point in time, since the switching element 14 has been turned OFF, the current flows through the parasitic diode 17 of the switching element 14. Thus, since the point a becomes (-) and the point b becomes (+), the output of the comparator 15 becomes high and the switching element 14 is turned ON. The voltage drop of the switching element 14 in this case is considerably smaller as compared with a conventional power supply circuit using a diode. Consequently, the efficiency thereof is improved. If the switching element 11 is turned ON before the energy stored in the inductor 12 has completely been released, the same operation is repeatedly performed from the start point initially described about this operation.

[0015]

Next, if the switching element 11 is not turned

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ON even after the switching element 11 has been turned OFF and the energy stored in the inductor 12 has completely been released (i.e., when the load is light), then current I_{off2} flows such that the energy stored in the capacitor 13 is transmitted through the inductor 12 to GND. In this case, since the point a becomes (+) and the point b becomes (-), a low level signal is supplied to the switching element 14, so that the switching element 14 is turned OFF instantaneously. That is to say, since this current no longer flows, an operation mode in which power returns from the load to the power supply does not exist. Consequently, even when the load is light, the efficiency of the power supply is not decreased. In actuality, it is only after the current I_{off2} starts to flow that the comparator 15 turns the switching element 14 OFF. As a result, a very small amount of current is stored in the inductor 12 before the turn OFF of the switching element 14 and power returns to the power supply via a current path I_{off3} . However, since the amount of the returning power is very small and the power to be lost in this mode is even smaller, such a delay is negligible in practical use.

[0016]

[Effect of the Invention]

As is apparent from the foregoing description, according to this invention, even when a load is light, the efficiency of a power supply is not decreased and the capacitance of an inductor need not be increased. Thus, this invention can also contribute to cost reduction.

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[Brief Description of the Drawings]

[Figure 1]

A circuit diagram showing an example of this invention.

[Figure 2]

A circuit diagram showing a conventional example.

[Figure 3]

A circuit diagram showing another conventional example.

[Description of the Reference Numerals]

11, 14 switching element

12 inductor

13 capacitor

15 comparator

16, 17 parasitic diode

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[Abstract]

[Objective] This invention relates to a high-efficiency power supply circuit such as a DC-DC converter suitably applicable to portable units like personal computers, in particular. The objective of this invention is to provide a high-efficiency power supply circuit which can efficiently supply power even when a load is light.

[Structure] The high-efficiency power supply circuit of this invention is a DC-DC converter including: a first switching element to be turned ON/OFF in response to an external signal; an inductor for supplying energy to a load in accordance with a state of the first switching element; a rectifying diode; and a smoothing capacitor. The high-efficiency power supply circuit is characterized by further including a second switching element which is connected in parallel to the rectifying diode, and is controlled to be bidirectionally turned ON/OFF in synchronism with the first switching element, and a comparator for detecting a voltage drop by the rectifying diode and the second switching element and detecting the direction of current flowing through the inductor, thereby turning ON/OFF the second switching element.

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【実用新案登録請求の範囲】

【請求項1】 外部信号によりオンオフする第1のスイッチング素子と、第1のスイッチング素子の状態に従い負荷に対してエネルギーを供給するインダクタと、整流ダイオード、平滑コンデンサで構成されるDC-DCコンバータにおいて、上記整流ダイオードと並列に接続され、第1のスイッチング素子と同期して両方向にオンオフ制御を行う第2のスイッチング素子と、上記整流ダイオードならびに第2のスイッチング素子による電圧降下を検出してインダクタに流れる電流の方向を検出して第2のスイッチング素子をオンオフするコンパレータとを

FIG.1

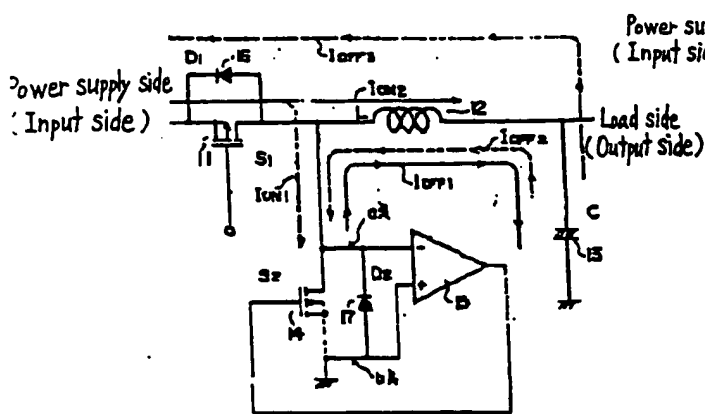
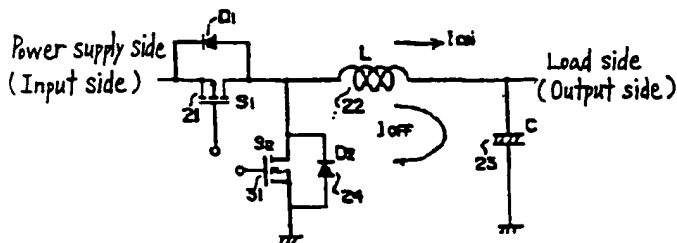


FIG.3



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具備することを特徴とする高効率電源回路。

【図面の簡単な説明】

【図1】 本考案の実施例を示す回路図。

【図2】 従来例を示す回路図。

【図3】 従来例を示す回路図である。

【符号の説明】

11、14…スイッチング素子

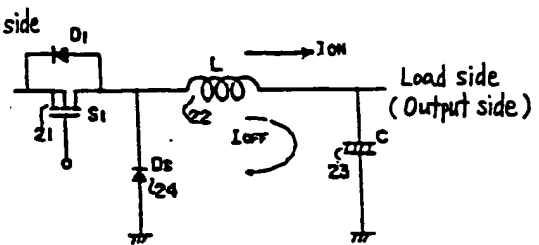
12…インダクタ

13…コンデンサ

15…コンパレータ

16、17…整流ダイオード

FIG.2



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優先権 特許

(71) 出願人 000003078

株式会社東芝

神奈川県川崎市幸区堀川町72番地

(71) 出願人 000221052

東芝コンピュータエンジニアリング株式会
社

東京都青森市新町1381番地1

(72) 発明者 森岡 静夫

東京都青森市新町1381番地1 東芝コンピ
ュータエンジニアリング株式会社内

(74) 代理人 弁護士 須山 佐一 (外1名)

(54) 【発明の名称】 高効率電源回路

(57) 【要約】

【目的】 この発明は、特にパーソナルコンピュータ等ポータブル機器に用いて好適なDC-DCコンバータ等高効率電源回路に関し、軽負荷時にも、効率よく電力供給が可能な高効率電源回路を提供することを目的とする。

【構成】 外部信号によりオンオフする第1のスイッチング素子と、第1のスイッチング素子の状態に従い負荷に対してエネルギーを供給するインダクタと、整流ダイオード、平滑コンデンサで構成されるDC-DCコンバータにおいて、上記整流ダイオードと並列に接続され、第1のスイッチング素子と同期して同方向にオンオフ制御を行う第2のスイッチング素子と、上記整流ダイオードならびに第2のスイッチング素子による電圧降下を検出してインダクタに流れる電流の方向を検出して第2のスイッチング素子をオンオフするコンパレータとを具備することを特徴とする。

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【実用新案登録請求の範囲】

【請求項1】 外部信号によりオンオフする第1のスイッチング素子と、第1のスイッチング素子の状態に従い負荷に対してエネルギーを供給するインダクタと、整流ダイオード、平滑コンデンサで構成されるDC-DCコンバータにおいて、上記整流ダイオードと並列に接続され、第1のスイッチング素子と同期して両方向にオンオフ制御を行う第2のスイッチング素子と、上記整流ダイオードならびに第2のスイッチング素子による電圧降下を検出してインダクタに流れる電流の方向を検出して第2のスイッチング素子をオンオフするコンパレータとを

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具備することを特徴とする高効率電源回路。

【図面の簡単な説明】

【図1】 本発明の実施例を示す回路図。

【図2】 従来例を示す回路図。

【図3】 従来例を示す回路図である。

【符号の説明】

11、14…スイッチング素子

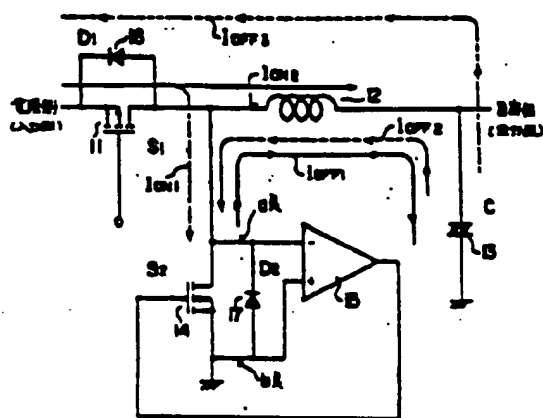
12………インダクタ

13………コンデンサ

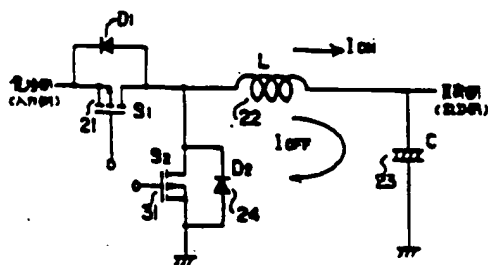
15………コンパレータ

16、17…寄生ダイオード

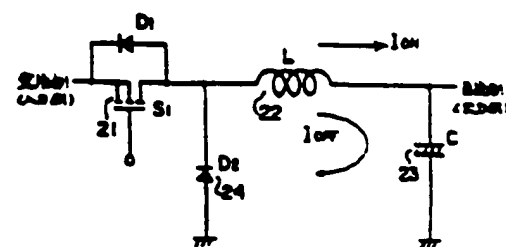
【図1】



【図3】



【図2】



(9 重 の 正 規 表 示)

10001

(4) (b) *

(2000)

1565 MW 3 (EJ)

この町では、特にパーソナルコンピュータ等パーソナル機器に角いて新しい
OC-C-OCコンバータを製造会社に属する。

00031

「歴史の教科書」

ハーノナカコンピュータシステムでは、通常としてDC-DCコンバータが用いられる。DC-DCコンバータの基本構造を図3に示す。DC-DCコンバータは、外巻の電圧によりON/OFFするバイポーラトランジスタとスイッチング素子で、エミッタを接地するコイルが主回路で構成される。

10204

是の時期に以下のとおりである。まず、スイッチング素子にMOSFETを用いた回路が採用され、入力側から出力側へエネルギーが伝達される。また、スイッチング素子にMOSFETを用いると、10W なる電圧がインダクタに22に増幅されてエネルギーが抽出される。このとき電圧スイーディングの動作原理は、インダクタに22に増幅されたエネルギーの一部分が失われる。

100%

ダイオードによる損失を少なくするために改良されたDC-DCコンバータの
 動作を図3に示す。図3に示すように、スイッチング素子1と制御のスイ
 ッチング素子2とを同時に両方向スイッチング動作をなされるスイッチング
 素子1をOFFにする。これら2つのスイッチング素子1とOFF、スイッチング素子2
 をONしている間はスイッチング素子2をONするという動作を繰り返す。両方
 のスイッチング素子2をONするのと同じように、ダイオード2は

TL-004127

の威力が電圧降下に比してはるかに大きいことと増幅したものである。

100081

(7500円以上とす4日間)

国によらずに、インフラタタタに要するたエネルギが全に供給さ
 れた時に、スイッチングタタタのONする順序モードでは、つまり、同時に
 消費されないゆへにエネルギが同時に異なる場合、同時に消費されないかんエ
 ネルギがある一量インフラタタタに消費エネルギとして消費され、これが同時に
 消費エネルギという形で要することになる。このように供給量から消費量にエネ
 ルギがあるため、同時に電力要求が生じ、電圧降下を招く。このため、
 電圧が大い異質に於いては、いかなる負荷に要する電力を供給することかど
 くない。また、これを第3図に示す回路構成で説明しようとする場合はインフラタ
 タの電圧が大さく成ります。

1000

本書は上記事情に鑑みてなされたものであり、何れの場合も、恐らく著者が刊行の経済的困難を覚悟することと見做す。

10001

【今更の知命】

10001

（四國を解放するたぬの平量！）

本年度は、員数増加によりオンオフ化する期1のスイッチング部手と、期1のスイッチング部手の状態に異なる負荷に対してエネルギーを供給するインダクタと、電源ダイオード、平滑コンデンサで構成されるDC—DCコンバータにおいて、上記電源ダイオードと平滑コンデンサの、期1のスイッチング部手と同様に両方共にオンオフ期間で行う要するのスイッチング部手と、上記電源ダイオードからひき出せるのスイッチング部手による電圧降下を吸収してインダクタに流れる電流の方向を抽出して流すのスイッチング部手をオンオフするコンバータとを異なりすることとする。

100101

1801

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